F ENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 09 August 1999 (09.08.99)	
International application No. PCT/US98/18090	**Applicant's or agent's file reference** RCA 88790
International filing date (day/month/year) 01 September 1998 (01.09.98)	**Priority date** (day/month/year) 12 December 1997 (12.12.97)
Applicant KNUTSON, Paul, Gothard et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

29 June 1999 (29.06.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Marie-José Devillard
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
RCA 88790		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 98/ 18090	01/09/1998	12/12/1997
Applicant		
THOMSON CONSUMER ELECTRONICS, INC. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] **Certain claims were found unsearchable** (see Box I).

2. [ ] **Unity of invention is lacking** (see Box II).

3. [ ] The international application contains disclosure of a **nucleotide and/or amino acid sequence listing** and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] Transcribed by this Authority

4. With regard to the **title,**
   - [X] the text is approved as submitted by the applicant
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**
   - [X] the text is approved as submitted by the applicant
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this International Search Report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is:
   Figure No. 3
   - [X] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

TRIPOLI, J.
THOMSON MULTIMEDIA LICENSING INC.
P.O. Box 5312
Princeton, New Jersey 08540
ETATS-UNIS D'AMERIQUE

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	16.03.00
Applicant's or agent's file reference RCA 88790	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US98/18090	01/09/1998	12/12/1997

Applicant
THOMSON CONSUMER ELECTRONICS, INC. et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Mader, D Tel.+49 89 2399-2744

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
RCA 88790		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US98/18090	01/09/1998	12/12/1997
International Patent Classification (IPC) or national classification and IPC H04B7/26		
Applicant THOMSON CONSUMER ELECTRONICS, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/06/1999	16.03.00
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Giglietto, M Telephone No. +49 89 2399 8214

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US98/18090

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-13 as originally filed

Claims, No.:

1-19 as originally filed

Drawings, sheets:

1/3-3/3 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1-19
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-19
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-19
	No:	Claims

2. Citations and explanations

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The application relates to TDMA wireless telecommunication systems.

2. The closest prior-art is sufficiently described by the applicant on pages 1-2 (two-part form not necessary).

3. Object of the present invention is to provide a radio telecommunication system which is able to allocate the fixed radio bandwidth available in an efficient way. The prior-art shows systems having a fixed allocation of the radio resource and designed for serving N handsets simultaneously. When less than N handsets are active part of the radio channel is not used, while a (N+1)-th handset is not accepted.

4. The application does not meet the requirements of Article 6 PCT (see section VIII of this Report), however, as far as can be understood a TDMA system is proposed in claim 1 comprising inter-alia means for determining when a new link would exceed the available channel capacity and means for alternatingly sharing the use of a previously allocated time slot (cf. time slice) with at least a second handset by reducing the number of bits used for each sample (cf. data sample size).

   A corresponding transmission method and handset are proposed in claims 10 and 19 respectively (see also section VIII).

5. These features of independent claims 1, 10 and 19 are not known from any of the available prior-art documents nor are they rendered obvious thereby:

   EP-A-0 587 225: discloses a system able to allocate the channel bandwidth to a plurality of low-rate terminals transmitting at a rate less than the capacity of the physical channel and a method for optimizing reallocation of the radio resource. Said system, however is still based on a fixed allocation method. No time slice sharing is shown nor a variable sample size.

Therefore, the subject-matter of claims 1, 10 and 10 meets the requirements of Art. 33(2) and (3) PCT.

The dependent claims add further features to the independent claims and thus also relate to novel and inventive subject-matter.

Re Item VIII

Certain observations on the international application

1. The term "sample size" used in the independent claims is vague and unclear and leaves the reader in doubt as to the meaning of the technical features to which it refers, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

2. The term "epoch" used in claims 3-5, 9, 12-14 and 18 has no well-recognised meaning and leaves the reader in doubt as to the meaning of the technical features to which it refers, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

3. **Claim 3** relates to a system comprising wireless handsets. However, the features recited at lines 6-8 and 9-12 in the system claim 3 relate to a method of using the system rather than clearly defining the system in terms of its technical features. The intended limitations are therefore not clear from this claim, contrary to the requirements of Article 6 PCT.

   The same objection is raised to **claim 4** regarding the feature recited at lines 18-20 and **claim 9** regarding the feature recited at lines 22-23.

4. **Claim 19** relates to a wireless handset for use in a TDMA system for communicating with a base unit in a time slice of the TDMA scheme and comprising means for reducing the data sample size such that the same time slice can be shared with other handsets.
   However, some of the features in the wireless handset recited in claim 19 relate to the system (i.e. lines 19-25) rather than clearly defining the apparatus in terms of

its technical features. The intended limitations are therefore not clear from this claim, contrary to the requirements of Article 6 PCT.

5. The word "which" appears to be missing in claim 1, line 6.

6. The **vague and imprecise** statement in the description on page 13 implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, PCT/GL/3 III, 4.3a).

CLAIMS

1. A wireless telephone system, comprising:

(a) a base unit (110) coupleable to one or more external telephone lines and having a base transceiver (111, 112);

(b) a plurality of wireless handsets (120_1 – 120_N) may be active or inactive, each having a handset transceiver for establishing a time-division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via the base transceiver, in which each active handset communicates during an time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice; and

(c) means (113) for allowing at least two handsets to alternatively share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity, by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

2. The system of claim 1, wherein the data samples are adaptive differential pulse code modulation (ADPCM) samples, each ADPCM sample having a number of bits.

3. The system of claim 1, wherein:

the plurality of handsets comprises exactly N wireless handsets;

the TDMA scheme comprising an epoch having N transmit data rows and N receive data rows;

each active handset capable of receiving or transmitting 16 4-bit ADPCM samples during each time slice for said handset when no handsets share time slices; and

when at least two handsets sharing a time slice for one of said two handsets, each of said two handsets receiving or transmitting 32 2-bit ADPCM samples during each alternate shared time slice for each said handset.

4. The system of claim 1, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset; and

each active handset receiving data and transmitting data via a data slice only once during each epoch, during the transmit and receive data row pair for each said active handset.

5. The system of claim 1, wherein the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset, each row comprising a field of data and being divided into a specified number of time slices, wherein each field is 2ms in length.

6. The system of claim 1, wherein the TDMA scheme is a variable TDMA scheme in which the number of handsets is greater than the maximum number of links that may be established over the channel.

7. The system of claim 1, wherein the TDMA scheme is a fixed TDMA scheme in which the number of handsets is equal to the maximum number of links that may be established over the channel.

8. The system of claim 1, wherein:

the plurality of handsets comprises 8 handsets;

up to 4 handsets may be active using without sharing time slices; and

up to 8 handsets may be active by sharing time slices..

9. The system of claim 1, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset;

each handset is battery-powered; and

each active handset turns on during the epoch only during its own time slice and turns off otherwise.

10. In a wireless telephone system having a base unit (110) and a plurality of wireless handsets (120_1 – 120_N), wherein the base unit is coupleable to one or more external telephone lines and has a base transceiver (111, 112), each of the plurality of wireless handsets may be active or inactive, and each handset comprises a handset transceiver (121, 122), a method comprising the steps of:

(a) establishing, with the handset transceiver for each active handset, a TDMA link over a shared RF channel with the base unit via the base transceiver, in which each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice; and

(b) allowing at least two handsets to alternatively share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity, by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

11. The method of claim 10, wherein the data samples are adaptive differential pulse code modulation (ADPCM) samples, each ADPCM sample having a number of bits.

12. The method of claim 10, wherein:

the plurality of handsets comprises exactly N wireless handsets;

the TDMA scheme comprises an epoch having N transmit data rows and N receive data rows;

each active handset receives or transmits 16 4-bit ADPCM samples during each time slice for said handset when no handsets share time slices; and

when at least two handsets share a time slice for one of said two handsets, each of said two handsets receives or transmits 32 2-bit ADPCM samples during each alternate shared time slice for each said handset.

13. The method of claim 10, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset; and

each active handset receives data and transmits data via a data slice only once during each epoch, during the transmit and receive data row pair for each said active handset.

14. The method of claim 10, wherein the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset, each row comprising a field of data and being divided into a specified number of time slices, wherein each field is 2ms in length.

15. The method of claim 10, wherein the TDMA scheme is a variable TDMA scheme in which the number of handsets is greater than the maximum number of links that may be established over the channel.

16. The method of claim 10, wherein the TDMA scheme is a fixed TDMA scheme in which the number of handsets is equal to the maximum number of links that may be established over the channel.

17. The method of claim 10, wherein:
the plurality of handsets comprises 8 handsets;
up to 4 handsets may be active using without sharing time slices; and
up to 8 handsets may be active by sharing time slices..

18. The method of claim 10, wherein:
the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset;
each handset is battery-powered; and
each active handset turns on during the epoch only during its own time slice and turns off otherwise.

19. A wireless handset for use with a wireless telephone system having a base unit and a plurality of wireless handsets, the plurality of wireless handsets including the wireless handset, wherein the base unit is coupleable to one or more external telephone lines and has a base transceiver, the wireless handset comprising:

(a) a handset receiver; and

(b) a handset transmitter, wherein:

each of the plurality of wireless handsets may be active or inactive;

the handset receiver and handset transmitter provide a handset transceiver for establishing a time-division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via a base transceiver for the handset;

each other handset of the plurality of wireless handsets comprises a handset transceiver for establishing a TDMA link, when said other handset is active, over a shared RF channel with the base unit via

the base transceiver, in which each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice; and

at least two handsets of the plurality of handsets alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity, by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

PATENT COOPERATION TREATY

REC'D 13 JUN 2000
WIPO PCT

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
RCA 88790		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US98/18090	01/09/1998	12/12/1997
International Patent Classification (IPC) or national classification and IPC		
H04B7/26		
Applicant		
THOMSON CONSUMER ELECTRONICS, INC. et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29/06/1999	16.03.00
Name and mailing address of the international preliminary examining authority:	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Giglietto, M Telephone No. +49 89 2399 8214

Form PCT/IPEA/409 (cover sheet) (January 1994)

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1,3-13	as originally filed			
2	as received on	28/02/2000	with letter of	28/02/2000

Claims, No.:

1-19	as received on	28/02/2000	with letter of	28/02/2000

Drawings, sheets:

1/3-3/3	as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims 1-19
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-19
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-19
	No:	Claims

2. Citations and explanations

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The application relates to TDMA wireless telecommunication systems.

2. The closest prior-art is sufficiently described by the applicant on pages 1-2 (two-part form not necessary).

3. Object of the present invention is to provide a radio telecommunication system which is able to allocate the fixed radio bandwidth available in an efficient way. The prior-art shows systems having a fixed allocation of the radio resource and designed for serving N handsets simultaneously. When less than N handsets are active part of the radio channel is not used, while a (N+1)-th handset is not accepted.

4. The application does not meet the requirements of Article 6 PCT (see section VIII of this Report), however, as far as can be understood a TDMA system is proposed in claim 1 comprising inter-alia means for determining when a new link would exceed the available channel capacity and means for alternatingly sharing the use of a previously allocated time slot (cf. time slice) with at least a second handset by reducing the number of bits used for each sample (cf. data sample size).

   A corresponding transmission method and handset are proposed in claims 10 and 19 respectively (see also section VIII).

5. These features of independent claims 1, 10 and 19 are not known from any of the available prior-art documents nor are they rendered obvious thereby:

   EP-A-0 587 225: discloses a system able to allocate the channel bandwidth to a plurality of low-rate terminals transmitting at a rate less than the capacity of the physical channel and a method for optimizing reallocation of the radio resource. Said system, however is still based on a fixed allocation method. No time slice sharing is shown nor a variable sample size.

Therefore, the subject-matter of claims 1, 10 and 10 meets the requirements of Art. 33(2) and (3) PCT.

The dependent claims add further features to the independent claims and thus also relate to novel and inventive subject-matter.

Re Item VIII

Certain observations on the international application

1. The term "sample size" used in the independent claims is vague and unclear and leaves the reader in doubt as to the meaning of the technical features to which it refers, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

2. The term "epoch" used in claims 3-5, 9, 12-14 and 18 has no well-recognised meaning and leaves the reader in doubt as to the meaning of the technical features to which it refers, thereby rendering the definition of the subject-matter of said claims unclear (Article 6 PCT).

3. **Claim 3** relates to a system comprising wireless handsets. However, the features recited at lines 6-8 and 9-12 in the system claim 3 relate to a method of using the system rather than clearly defining the system in terms of its technical features. The intended limitations are therefore not clear from this claim, contrary to the requirements of Article 6 PCT.

   The same objection is raised to **claim 4** regarding the feature recited at lines 18-20 and **claim 9** regarding the feature recited at lines 22-23.

4. **Claim 19** relates to a wireless handset for use in a TDMA system for communicating with a base unit in a time slice of the TDMA scheme and comprising means for reducing the data sample size such that the same time slice can be shared with other handsets.
   However, some of the features in the wireless handset recited in claim 19 relate to the system (i.e. lines 19-25) rather than clearly defining the apparatus in terms of

its technical features. The intended limitations are therefore not clear from this claim, contrary to the requirements of Article 6 PCT.

5. The word "which" appears to be missing in claim 1, line 6.

6. The **vague and imprecise** statement in the description on page 13 implies that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity (Article 6 PCT) when used to interpret them (see also the PCT Guidelines, PCT/GL/3 III, 4.3a).

One problem that arises due to the fixed capacity or bandwidth available for such telephone systems and the inflexibility of such systems is that the available channel capacity may be inefficiently utilized when not all handsets are operating. This is because, in some such systems, such as that disclosed for example, in European Patent Application No. 0 587 225 A2, the channel capacity is selected so that all N handsets can operate simultaneously, if necessary. However, when less than N handsets are operating, channel capacity is underutilized. Overall signal quality may be reduced in order to also reduce the total bandwidth (and thus the amount wasted when not all handsets are employed), but this reduces quality needlessly in some cases, for example where only one handset is operating and there is enough total channel capacity available to allow the single handset to communicate at high quality.

SUMMARY

A wireless telephone system comprises a base unit coupleable to one or more external telephone lines and having a base transceiver, and a plurality of wireless handsets which may be active or inactive. Each handset has a handset transceiver for establishing a time-division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via the base transceiver. In communicating via a TDMA link, each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice. At least two handsets alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity. Time slices are shared by reducing the sample size and thereby increasing

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H04B 7/26, H04L 1/12

A1

(11) International Publication Number: WO 99/31827

(43) International Publication Date: 24 June 1999 (24.06.99)

(21) International Application Number: PCT/US98/18090

(22) International Filing Date: 1 September 1998 (01.09.98)

(30) Priority Data:
60/069,343 12 December 1997 (12.12.97) US

(71) Applicant *(for all designated States except US)*: THOMSON CONSUMER ELECTRONICS, INC. [US/US]; 10330 North Meridian Street, Indianapolis, IN 46290–1024 (US).

(72) Inventors; and
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(54) Title: TIME–DIVISION MULTIPLE ACCESS (TDMA) MULTI–LINE WIRELESS TELEPHONE SYSTEM

300

DATA	AUDIO CHANNEL							
TD1	TS1 (TS5)	RS1 (RS5)	TS2 (TS6)	RS2 (RS6)	TS3 (TS7)	RS3 (RS7)	TS4 (TS8)	RS4 (RS8)
RD1	TS5 (TS1)	RS5 (RS1)	TS6 (TS2)	RS6 (RS2)	TS7 (TS3)	RS7 (RS3)	TS8 (TS4)	RS8 (RS4)
•••	•••	•••	•••	•••	•••	•••	•••	•••
•••	•••	•••	•••	•••	•••	•••	•••	•••
TDn	TS1 (TS5)	RS1 (RS5)	TS2 (TS6)	RS2 (RS6)	TS3 (TS7)	RS3 (RS7)	TS4 (TS8)	RS4 (RS8)
RDn	TS5 (TS1)	RS5 (RS1)	TS6 (TS2)	RS6 (RS2)	TS7 (TS3)	RS7 (RS3)	TS8 (TS4)	RS8 (RS4)

(57) Abstract

A wireless telephone system comprises a base unit coupleable to one or more external telephone lines and having a base transceiver, and a plurality of wireless handsets which may be active or inactive. Each handset has a handset transceiver for establishing a time–division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via the base transceiver. In communicating via a TDMA link, each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice. At least two handsets alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity. Time slices are shared by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

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TIME-DIVISION MULTIPLE ACCESS (TDMA) MULTI-LINE WIRELESS TELEPHONE SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to multi-line wireless telephone systems.

Description of the Related Art

The use of telephones and telephone systems, including wireless telephone systems, is widespread. In wireless telephone systems, a cordless or wireless telephone handset unit communicates via either analog or digital radio signals with a base unit, which is typically connected via a standard telephone line to an external telephone network. In this manner, a user may employ the wireless handset to engage in a telephone call with another user through the base unit and the telephone network.

Multi-line wireless telephone systems are also in use in various situations, such as businesses with many telephone users. Such systems employ a handset that communicates with up to N handsets simultaneously, typically with digital communications schemes, such as time division multiple access (TDMA). It is desirable to implement the features of current private branch exchange (PBX) systems in a multi-line wireless telephone system. Conventional multi-line wireless telephone systems typically must work within a specified bandwidth and modulation format, which thus constrains the maximum capacity of the radio-frequency (RF) channel used to transmit signals between the base unit and the operating or active handsets.

One problem that arises due to the fixed capacity or bandwidth available for such telephone systems and the inflexibility of such systems is that the available channel capacity may be inefficiently utilized when not all handsets are operating. This is because, in some such systems, the channel capacity is selected so that all N handsets can operate simultaneously, if necessary. However, when less than N handsets are operating, channel capacity is underutilized. Overall signal quality may be reduced in order to also reduce the total bandwidth (and thus the amount wasted when not all handsets are employed), but this reduces quality needlessly in some cases, for example where only one handset is operating and there is enough total channel capacity available to allow the single handset to communicate at high quality.

SUMMARY

A wireless telephone system comprises a base unit coupleable to one or more external telephone lines and having a base transceiver, and a plurality of wireless handsets which may be active or inactive. Each handset has a handset transceiver for establishing a time-division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via the base transceiver. In communicating via a TDMA link, each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice. At least two handsets alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity. Time slices are shared by reducing the sample size and thereby increasing

the number of data samples transmitted during said shared time slices.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of TDMA multi-line wireless telephone system, in accordance with an embodiment of the present invention;

Fig. 2 is a schematic representation of the field, data packet, and audio packet structures used in the TDMA scheme of the system of Fig. 1;

Fig. 3 is a table illustrating a variable-structure TDMA time slice allocation scheme used by the system of Fig. 1, in accordance with an embodiment of the present invention; and

Fig. 4 is a table illustrating a fixed-structure TDMA time slice allocation scheme used by the system of Fig. 1, in accordance with an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to Fig. 1, there is shown a block diagram of TDMA multi-line wireless telephone system 100, in accordance with an embodiment of the present invention. TDMA system 100 comprises a base unit 110, which has receiver and transmitter units 112 and 111, respectively, and is coupled to external telephone network 116 via telephone line(s) 115. Base unit 110 also has a controlled microprocessor 113 for controlling and monitoring the overall functions of the base unit 110. System 100 also comprises N wireless handsets 120_1, 120_2, . . . 120_N. Each has a transmitter and receiver unit (transceiver), such as transmitter 121 and receiver 122 of handset 120_1. In one embodiment, receiver unit 112 comprises N separate logical receivers, and transmitter unit 111 comprises N separate logical transmitters, so that receiver and transmitter units 112 and 111 provide N total logical transceiver units, one for each of

N wireless handsets. At any given time, M handsets ($0 \leq M \leq N$) are operating (i.e., in the process of conducting a telephone call). Efficient power use is important for a wireless system since the handsets are typically battery-powered. In one embodiment, therefore, system 100 employs a digital TDMA scheme, as described in further detail below, which allows power to be efficiently used since each operating handset is "off" (i.e., not transmitting or receiving data) most of the time, and is only "on" during its own "time slice" or slot. System 100 thus provides a wireless network between the base station 110 and each handset 120_i ($1 \leq i \leq N$).

In the present invention, a TDMA scheme is employed that allows available channel capacity to be more efficiently utilized. This is done by reducing the quality of two or more handset signals and having them alternate each others' time slices, when a certain number of handsets are in operation, as explained in further detail below with reference to Figs. 2-4.

Referring now to Fig. 2, there is shown a schematic representation 200 of the field, data packet, and audio packet structures used in the TDMA scheme of TDMA system 100 of Fig. 1. In one embodiment, a 2 ms field 210 of digital data comprises nine total packets, viz. a data packet 220 and eight audio packets such as audio packet 230. Each data packet is a set of data transmitted either to a given handset from the base unit or vice-versa, during a discrete time slice during which time no other handsets receive or transmit data over the system's data channel. Each audio packet is a set of audio data transmitted either to a given handset from the base unit or vice-versa, during a given time-slice in an overall "epoch" scheme, again during which time no other handsets receive or transmit data over the system's data channel.

As illustrated, each type of packet contains various sub-fields or sections. For example, data packet 220 comprises a 32-bit sync field 222, a data field 235, a FEC (forward error correction) field 222, and guard time 223. The data in data packet 220 is used to communicate between the base unit and a particular handset, and contains various types of information, such as caller ID type information, range and power information, and the like.

Audio packet 230 comprises an audio packet header 231, FEC data section 232, and guard time 233. Audio packet header 231, for example, contains information identifying the audio packet (such as the handset), the current place in the epoch, and the like.

In normal operation, each handset receives 16 digitally compressed audio samples (such as ADPCM (adaptive differential pulse code modulation) samples) during each time slice of the epoch allocated for the handset to receive audio data; and transmits to the base unit 16 ADPCM samples during each time slice of the epoch allocated for the handset to transmit audio data. In the present invention, however, when too many handsets are in operation for the channel capacity to carry, pairs of handsets share a time slice by alternating its use, and by doubling the number of samples to 32 per time slice (by lowering each sample's quality). ADPCM and related technical issues are described in detail in International Telecommunication Union (ITU), Recommendation G.727, (12/1990), "5-, 4-, 3- and 2-Bits Sample Embedded Adaptive Differential Pulse Code Modulation (ADPCM)," http://www.itu.ch.

Audio packet 230 therefore also comprises a main 64-bit "audio data" portion, which comprises either 16 4-bit ADPCM samples (high quality), or 32 2-bit ADPCM samples (low quality). The latter is the case when more handsets are operating than can operate at high

quality over the allocated maximum channel capacity of system 100. Thus, in the present invention, each handset in operation operates at high quality when there are fewer than T handsets operating (calls in place), where $M \leq T$ and the maximum channel capacity is sufficient to handle up to T high quality calls or links simultaneously. However, when there are more than T handsets in operation ($M > T$), then selected pairs of handset channels are switched from high quality audio links to low quality audio links and alternate time slices. As will be appreciated, for a 2 ms field, high quality (16 4-bit ADPCM samples per audio packet or time slice) provides 32Kbps ADPCM (the default audio data), and low quality (32 2-bit samples shared between two handsets, per audio packet) provides 16 Kbps.

Thus, at the limit, this embodiment of the present invention allows the maximum handset capacity at high quality to be doubled at low quality. In one embodiment of system 100, up to 4 handsets may conduct calls simultaneously at high quality, and up to 8 at low quality. For intermediate numbers, each additional handset added past 4 must pair up with one of the first 4 (e.g., if $M = 7$, there are 3 handsets above the first 4, and thus $3 \times 2 = 6$ of the 7 handsets are operating at low quality).

Referring now to Fig. 3, there is shown a Table 300 illustrating a variable-structure TDMA time slice allocation scheme epoch used by system 100 of Fig. 1, in accordance with an embodiment of the present invention. Table 300 contains N pairs of rows, one pair of rows for each existing handset. Each row is a field, such as field 210 of Fig. 2. In the variable structure scheme of Table 300, N may be greater than 8. For example, N may be 12. Each row or field of the epoch may be referred to herein by the initial time slice or slot, which is used to transmit data (TD) to a given handset, or to receive data

(RD) from a given handset. Thus, at the beginning of the field, data is transmitted (or received) from a specific handset. Thus, for example, base unit 110 transmits data to handset #1 (e.g., handset 120_1 of Fig. 1) in the first time slice of row TD1; and base unit 110 receives data from handset #1 in the first time slice of row RD1. Thus, each handset receives data and transmits data during one time slice of the entire Q-slice epoch, where Q = 9x2xN. Thus, although any number N handsets may be added, the time delay between data communication for a given handset 120_i and the base unit 110 is thereby lengthened. This can cause, for example, a longer time delay or latency for causing a given handset to ring or to be apprised of caller ID information.

In operation, a given handset polls at its specific data channel time slots for incoming calls and synchronization data from the base unit 110, and transmits audio packets over its specific data channel time slots when it initiates a call. The audio packet pairs (e.g., TS1, RS1) of each field 210 (each row of Table 300) can carry one conversation using 32Kbps ADPCM, or two conversations using 16Kbps ADPCM (see ITU Rec. G.727). In this embodiment, 16 4-bit samples are transferred every 2ms each direction for a handset. Note that Table 300 shows the time sequence left to right, top to bottom, 2 milliseconds horizontally, and 2x2xN ms (= 32ms for N=8) vertically.

In one embodiment, system 100 implements the epoch of Table 300 as follows. The channel capacity of system 100 is sufficient to allow up to T=4 handsets to operate at high quality. Thus, for the first four handsets to come into operation, they are assigned nominal numbers 1 through 4. As each time slice of Table 300 is cycled through (left to right, top to bottom), both rows of each row pair use the allocation shown by the top entry in the TD row, i.e. the entry not in parentheses. Thus, we have the following sequence:

TD1, TS1, RS1, TS2, RS2, TS3, RS3, TS4, RS4;

RD1, TS1, RS1, TS2, RS2, TS3, RS3, TS4, RS4;

TD2, TS1, RS1, TS2, RS2, . . .

. . .

RDN, TS1, RS1, TS2, RS2, TS3, RS3, TS4, RS4;

where "TS1" denotes the time slice during which an audio signal or "sound" packet is transmitted by base unit 110 to handset #1; and"RS1" denotes the time slice during which an audio packet is received by base unit 110 from handset #1; and so forth.

However, each audio packet time slice entry of Table 300 contains two entries. The top entry in TD rows or fields indicates the "normal" allocation for the slot for both TD and RD rows, when $M \leq T$. This allocation is used for both TD and RD rows of a row pair. For example, if only 4 handsets are active (off hook), then, the sequence described above is followed, i.e. both the TD and RD rows follow the sequence indicated by the top entry in the TD row.

The bottom entry, in parentheses, indicates the alternate allocation for the slot when $M > T$. The top entry indicates the normal alternating allocation when $M > T$. If a fifth handset (handset #5) becomes operative, there is not enough channel capacity to handle all 5 active or operative handsets at high quality. Therefore, handsets 1 and 5 share a time slice on alternate fields, and each audio packet doubles the number of samples it transmits during the time slice. For example, in this case, during the first audio packet time slice of row TD1, the entry TS1 indicates that 32 2-bit audio ADPCM samples are transmitted to handset #1, instead of the usual 16 4-bit samples. During the first audio packet time slice of row RD1, the entry TS5

indicates that 32 2-bit audio ADPCM samples are transmitted to handset #5 during this time slice. Providing 32 2-bit ADPCM samples in the audio packets for handsets 1 and provides enough audio data for a 4 millisecond TDMA cycle. The system is dynamic, since, if handset #1 hangs up before handset #5, the base unit 110 can allocate 32Kbps to handset #5 for the remainder of the call. Depending on when handset #5 becomes active, the order can switch, so that the entry in parenthesis is applicable.

Therefore, when M > T, system 100 may be said to be operating in a handset expansion mode. In normal mode, a total of 32 4-bit samples are transmitted to handset #1 every two fields (i.e., TS1 at high quality occurs twice). In handset expansion mode, 32 2-bit (low quality) samples are still transmitted to handset #1 every two fields, except this is done in a single audio packet rather than in two. As additional handsets are activated beyond the first 4, system 100 dynamically switches to handset expansion mode, and nominally numbers the newly-active handsets, which are then paired as illustrated with others' time slices, as illustrated. Thus, for example, if handset #6 becomes active, it shares alternating time slices with (and lowers the quality of) handset #2. In this case, we have:

TD1, TS1,* RS1,* TS2,* RS2,* TS3, RS3, TS4, RS4;

RD1, TS5,* RS5,* TS6,* RS6,* TS3, RS3, TS4, RS4;

TD2, TS1,* RS1,* TS2,* RS2,* TS3, RS3, . . .

. . .

RDN, TS5,* RS5,* TS6,* RS6,* TS3, RS3, TS4, RS4

where the asterisk indicates low-quality audio packets (i.e. 2-bit samples).

Thus, base unit 110 allocates transmit and receive slots to each subsequently active handset for audio transmission. If no handsets were in use, and handset 120_2 starts a call, transmit and receive slots TS1 and RS1 would be dedicated to handset 120_2 (i.e., handset #1) at 32Kbps rate. Thus, for up to 4 active handsets, a high quality audio link of 32Kbps is provided for each handset. As the 5th handset becomes activated, one existing channel is reduced to 16Kbps and the 5th handset is multiplexed into that channel with a 16Kbps rate. If more than 8 handsets attempt transmission, they are blocked (all circuits busy signal). In such an embodiment where blocking is possible, receiver unit 112 preferably comprises less than N separate receivers (preferably 8), and transmitter unit 111 comprises less than N separate transmitters (preferably 8). In general, in any embodiment base unit 110 comprises a number of logical transceiver pairs equal to the maximum number of calls (links) that may be established simultaneously.

Thus, in the epoch of Table 300, in normal mode, each active handset has fixed time slots for each field 210 (i.e. row of Table 300) for audio data transfer. In expanded handset mode, the low quality

handsets have fixed time slots for every other field 210 (i.e. row of Table 300) for audio data transfer.

In one embodiment, system 100 is adapted to dynamically re-nominate handsets to optimize channel capacity usage. For example, suppose 6 handsets are operating as described above, and thus 4 of the 6 handsets are operating in low-quality mode. Next, suppose handsets #3 and #4 deactivate. At this point, it makes no sense for handsets #1 and #5 to share time slices or operate at low quality mode, since time slices for TS3, RS3, TS4, RS4 are not being used. Thus, system 100 in this case dynamically re-numbers or re-nominates the four operating handsets as #s 1-4.

Thus, in the present invention, TDMA is used to separate the data and audio into two channels, and to allocate bandwidth as required to the handsets needing the channel. This technique is compatible with power saving protocols, since the data channel, which will always be available, is used to signal the handset and initiate calls. A specific time slot is provided for data for each handset, which is used to keep the TDMA in sync so that the handset transceiver communicates only during its designated time slice. Since the phones are battery operated, it is important that they transmit and listen only when they need to.

In one embodiment, the system 100 implements the epoch and scheme of Table 300 with a telephone system with 4 Plain Old Telephone System (POTS) lines (i.e., line 115). With four dedicated POTS lines, one can always expect 32Kbps performance except when multiple handsets are in conference, or if some handsets are in intercom while others are in line conversations. In alternative embodiments, other line/handset combinations may be used.

In the above-described embodiment, 2 transmit/receive pairs per audio data packet slot were used. In alternative embodiments, there may be fewer or more transmit/receive pairs per data slot. For example, the audio data samples could be reduced further in quality to transmit more samples per audio packet, to allow more than 2 handsets (e.g. 4) to share a time slice. However, this may require higher compression algorithms, which would add considerable delay to the loop. Using ADPCM as described above minimizes delay in the loop and simplifies the audio echo cancellation problem, and both 16Kbps and 32Kbps algorithms exhibit the same delay, easily facilitating switching between algorithms.

Referring now to Fig. 4, there is shown a Table 400 illustrating a fixed-structure TDMA time slice allocation scheme epoch used by system 100 of Fig. 1, in accordance with an embodiment of the present invention. In this embodiment, there is less flexibility in terms of adding additional handsets beyond the channel capacity. However, it may be simpler to implement than the variable approach of Table 300, and does not permit blocking to occur.

The epoch scheme illustrated in Table 400 may be implemented similarly to that of Table 300, when N=8. In one embodiment of Table 400, time slots are dedicated to each handset for both data and audio. Thus, for example, if handsets #1 and #5 were the only handsets active, they would each be operating at 16Kbps ADPCM, even though there is additional bandwidth or channel capacity available. However, although this may not be the most "efficient" way to use the channel, it allows for simplified control of the channel. In an alternative embodiment, system 100 in implementing the epoch of Table 400 may dynamically re-nominate handset numbers to more efficiently utilize the available bandwidth.

One skilled in the art will recognize that the wireless system described above according to the principles of the invention may be a cellular system where base unit 110 represents a base station serving one of the cells in a cellular telephone network.

It will be understood that various changes in the details, materials, and arrangements of the parts which have been described and illustrated above in order to explain the nature of this invention may be made by those skilled in the art without departing from the principle and scope of the invention as recited in the following claims.

CLAIMS

1. A wireless telephone system, comprising:

(a) a base unit coupleable to one or more external telephone lines and having a base transceiver;

(b) a plurality of wireless handsets which may be active or inactive, each having a handset transceiver for establishing a time-division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via the base transceiver, in which each active handset communicates during an time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice; and

(c) means for allowing at least two handsets to alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity, by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

2. The system of claim 1, wherein the data samples are adaptive differential pulse code modulation (ADPCM) samples, each ADPCM sample having a number of bits.

3. The system of claim 1, wherein:

the plurality of handsets comprises exactly N wireless handsets;

the TDMA scheme comprises an epoch having N transmit data rows and N receive data rows;

each active handset receives or transmits 16 4-bit ADPCM samples during each time slice for said handset when no handsets share time slices; and

when at least two handsets share a time slice for one of said two handsets, each of said two handsets receives or transmits 32 2-bit ADPCM samples during each alternate shared time slice for each said handset.

4. The system of claim 1, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset; and

each active handset receives data and transmits data via a data slice only once during each epoch, during the transmit and receive data row pair for each said active handset.

5. The system of claim 1, wherein the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset, each row comprising a field of data and being divided into a specified number of time slices, wherein each field is 2ms in length.

6. The system of claim 1, wherein the TDMA scheme is a variable TDMA scheme in which the number of handsets is greater than the maximum number of links that may be established over the channel.

7. The system of claim 1, wherein the TDMA scheme is a fixed TDMA scheme in which the number of handsets is equal to the maximum number of links that may be established over the channel.

8. The system of claim 1, wherein:

the plurality of handsets comprises 8 handsets;

up to 4 handsets may be active using without sharing time slices; and

up to 8 handsets may be active by sharing time slices..

9. The system of claim 1, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset;

each handset is battery-powered; and

each active handset turns on during the epoch only during its own time slice and turns off otherwise.

10. In a wireless telephone system having a base unit and a plurality of wireless handsets, wherein the base unit is coupleable to one or more external telephone lines and has a base transceiver, each of the plurality of wireless handsets may be active or inactive, and each handset comprises a handset transceiver, a method comprising the steps of:

(a) establishing, with the handset transceiver for each active handset, a TDMA link over a shared RF channel with the base unit via the base transceiver, in which each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice; and

(b) allowing at least two handsets to alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity, by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

11. The method of claim 10, wherein the data samples are adaptive differential pulse code modulation (ADPCM) samples, each ADPCM sample having a number of bits.

12. The method of claim 10, wherein:

the plurality of handsets comprises exactly N wireless handsets;

the TDMA scheme comprises an epoch having N transmit data rows and N receive data rows;

each active handset receives or transmits 16 4-bit ADPCM samples during each time slice for said handset when no handsets share time slices; and

when at least two handsets share a time slice for one of said two handsets, each of said two handsets receives or transmits 32 2-bit ADPCM samples during each alternate shared time slice for each said handset.

13. The method of claim 10, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset; and

each active handset receives data and transmits data via a data slice only once during each epoch, during the transmit and receive data row pair for each said active handset.

14. The method of claim 10, wherein the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset, each row comprising a field of data and being divided into a specified number of time slices, wherein each field is 2ms in length.

15. The method of claim 10, wherein the TDMA scheme is a variable TDMA scheme in which the number of handsets is greater than the maximum number of links that may be established over the channel.

16. The method of claim 10, wherein the TDMA scheme is a fixed TDMA scheme in which the number of handsets is equal to the maximum number of links that may be established over the channel.

17. The method of claim 10, wherein:

the plurality of handsets comprises 8 handsets;

up to 4 handsets may be active using without sharing time slices; and

up to 8 handsets may be active by sharing time slices..

18. The method of claim 10, wherein:

the TDMA scheme comprises an epoch having a plurality of transmit and receive data row pairs, one such row pair for each handset;

each handset is battery-powered; and

each active handset turns on during the epoch only during its own time slice and turns off otherwise.

19. A wireless handset for use with a wireless telephone system having a base unit and a plurality of wireless handsets, the plurality of wireless handsets including the wireless handset, wherein the base unit is coupleable to one or more external telephone lines and has a base transceiver, the wireless handset comprising:

(a) a handset receiver; and

(b) a handset transmitter, wherein:

each of the plurality of wireless handsets may be active or inactive;

the handset receiver and handset transmitter provide a handset transceiver for establishing a time-division multiple access (TDMA) link, when said handset is active, over a shared RF channel with the base unit via a base transceiver for the handset;

each other handset of the plurality of wireless handsets comprises a handset transceiver for establishing a TDMA link, when said other handset is active, over a shared RF channel with the base unit via the base transceiver, in which each active handset communicates during an exclusive time slice of a TDMA scheme that allocates time slices to active handsets, wherein a number of data samples having a sample size are transmitted during each time slice; and

at least two handsets of the plurality of handsets alternatingly share a time slice, when one of said two handsets is to establish a new TDMA link and when establishing said new TDMA link would exceed the available channel capacity, by reducing the sample size and thereby increasing the number of data samples transmitted during said shared time slices.

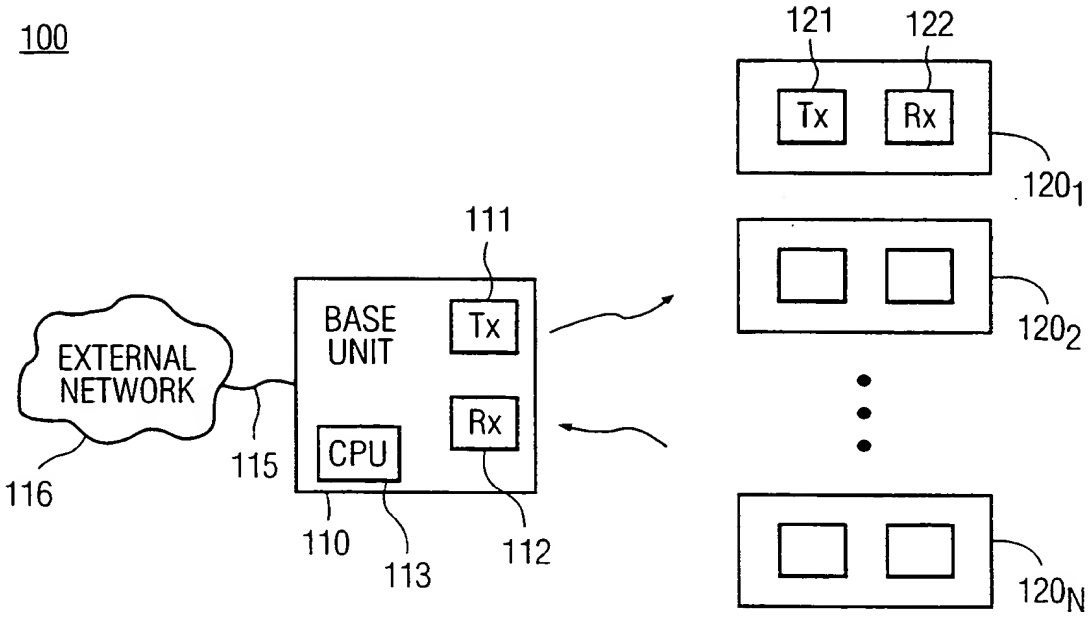
100
121
122
Tx
Rx
120_1
120_2
120_N
111
BASE UNIT
Tx
Rx
CPU
EXTERNAL NETWORK
116
115
110
113
112

FIG. 1

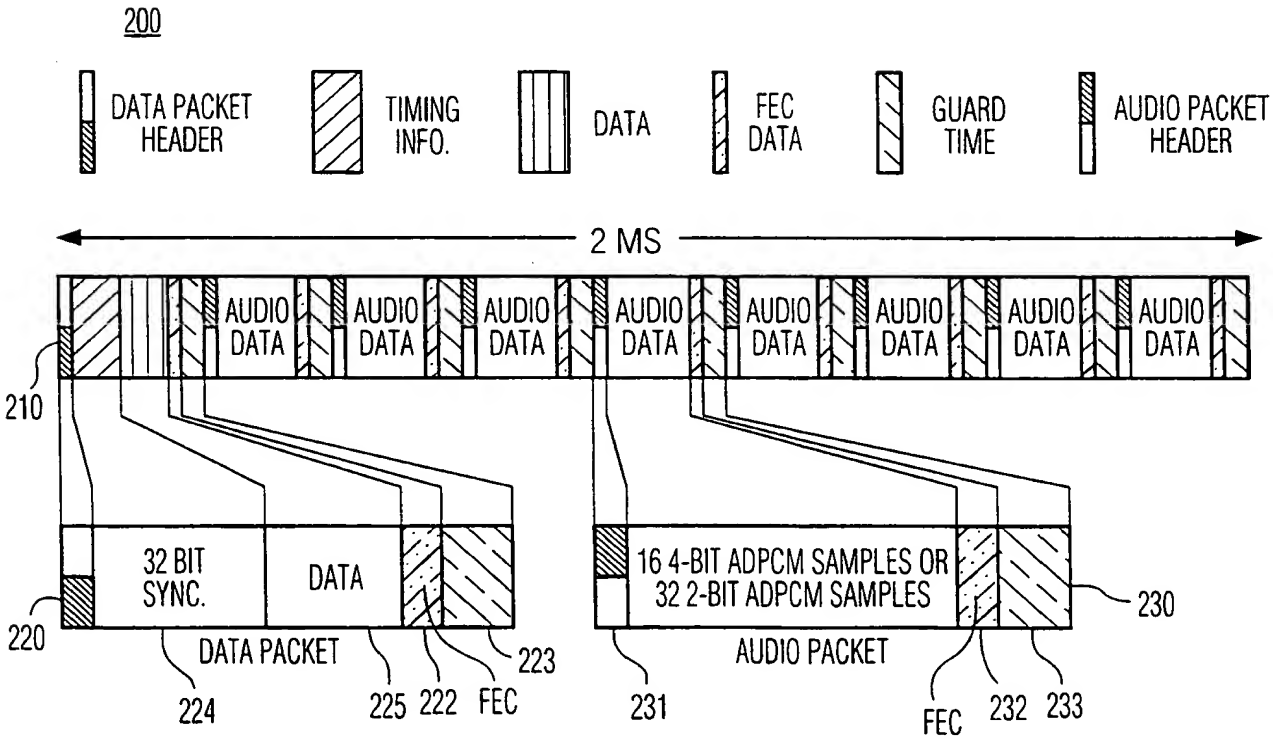
200
DATA PACKET HEADER
TIMING INFO.
DATA
FEC DATA
GUARD TIME
AUDIO PACKET HEADER
2 MS
AUDIO DATA
210
32 BIT SYNC.
DATA
220
DATA PACKET
224
225
222
FEC
223
16 4-BIT ADPCM SAMPLES OR 32 2-BIT ADPCM SAMPLES
230
AUDIO PACKET
231
FEC
232
233

FIG. 2

300

DATA	AUDIO CHANNEL							
TD1	TS1 (TS5)	RS1 (RS5)	TS2 (TS6)	RS2 (RS6)	TS3 (TS7)	RS3 (RS7)	TS4 (TS8)	RS4 (RS8)
RD1	TS5 (TS1)	RS5 (RS1)	TS6 (TS2)	RS6 (RS2)	TS7 (TS3)	RS7 (RS3)	TS8 (TS4)	RS8 (RS4)
•••	•••	•••	•••	•••	•••	•••	•••	•••
•••	•••	•••	•••	•••	•••	•••	•••	•••
TDn	TS1 (TS5)	RS1 (RS5)	TS2 (TS6)	RS2 (RS6)	TS3 (TS7)	RS3 (RS7)	TS4 (TS8)	RS4 (RS8)
RDn	TS5 (TS1)	RS5 (RS1)	TS6 (TS2)	RS6 (RS2)	TS7 (TS3)	RS7 (RS3)	TS8 (TS4)	RS8 (RS4)

FIG. 3

400

DATA	AUDIO CHANNEL							
TD1	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD1	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD2	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD2	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD3	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD3	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD4	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD4	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD5	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD5	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD6	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD6	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD7	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD7	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)
TD8	T1 (T5)	R1 (R5)	T2 (T6)	R2 (R6)	T3 (T7)	R3 (R7)	T4 (T8)	R4 (R8)
RD8	T5 (T1)	R5 (R1)	T6 (T2)	R6 (R2)	T7 (T3)	R7 (R3)	T8 (T4)	R8 (R4)

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/18090

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B7/26 H04L1/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04B H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 587 225 A (PHILIPS ELECTRONICS UK LTD ;PHILIPS ELECTRONICS NV (NL)) 16 March 1994 see abstract see page 3, line 1 - line 39 see page 4, line 12 - line 30 see claims 1,2; figures 1,2 ---	1-19
A	US 5 392 284 A (SUGIYAMA AKIRA) 21 February 1995 see column 4, line 1 - line 31 see column 6, line 23 - line 57 see figures 5B-1,5C,5D-2 --- -/--	1-19

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 January 1999	01/02/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lazaridis, P

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	INTERNATIONAL TELECOMMUNICATION UNION: "40, 32, 24, 16, kbit/s Adaptive differential pulse code modulation ADPCM" GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS. TERMINAL EQUIPMENTS, vol. 726, no. g, 23 April 1992, pages 1-4, 06, 08 - 15, XP002079675 see figures 1,2	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/18090

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0587225 A	16-03-1994	JP 6164492 A	10-06-1994
		US 5412650 A	02-05-1995
US 5392284 A	21-02-1995	JP 4129465 A	30-04-1992
		JP 4225650 A	14-08-1992